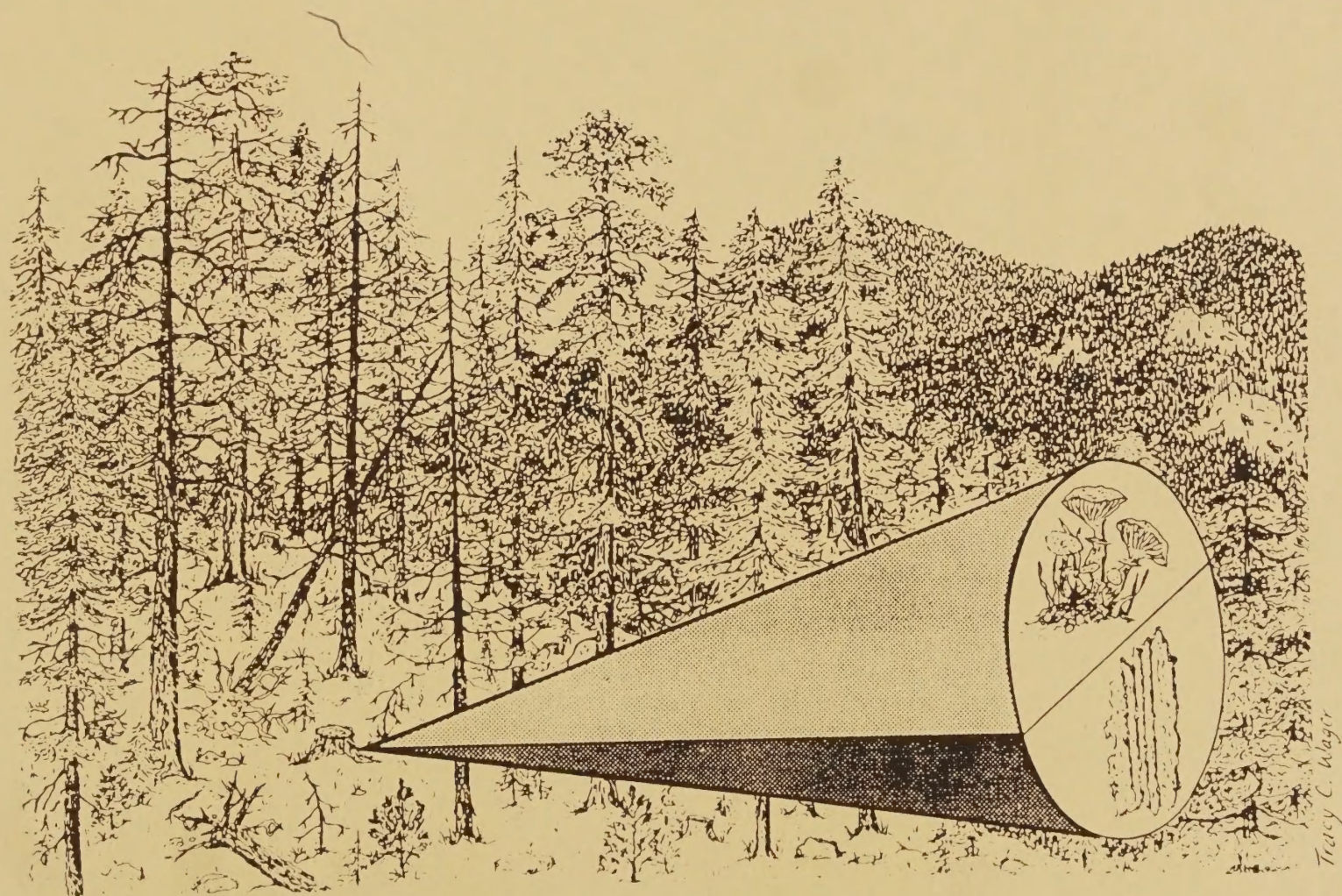


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ROOT DISEASE IN THE COEUR D'ALENE RIVER BASIN: AN ASSESSMENT

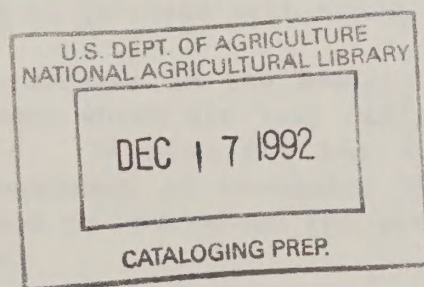


Idaho Panhandle National Forests
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Cover sketch was taken from the cover design for the User's Manual for Western Root Disease Model, Gen. Tech. Rep. INT-267, March 1990, illustrated by Tracy C. Wager.

ROOT DISEASE IN THE COEUR D'ALENE RIVER BASIN: AN ASSESSMENT

by

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Abstract

Root diseases play a major role in the ecology of conifer forests of the Coeur d'Alene River Basin, particularly in the grand fir and Douglas-fir cover types. Of the 732,000 acres in the Basin, approximately 238,000 acres have grand fir or Douglas-fir cover types, 90 percent of which are in timber management allocations in the Forest Plan for the Idaho Panhandle National Forests.

This report assesses current root disease impacts in the grand fir and Douglas-fir cover types. Using aerial photographs, root disease was detected on over 35 percent of the acres in the Coeur d'Alene River Basin; 62 percent of the infected acres were rated as severely impacted (Severity Class 3 and 4). Forest Plan yield estimates far exceed what is projected for these disease-impacted acres. Both the Wallace and Fernan Ranger Districts were found to have similar root disease severities. The grand fir habitat type group had a somewhat higher root disease severity than other habitat type groups. Disease severities tended to increase with stand age.

Severity of root disease in the Basin forests may be due to conifer species compositions which are very different from those present prior to the mid-1800's. To plan for the long-term health of the Basin forests, it is necessary to recognize the impact of root diseases in today's forests and to understand the processes that have shaped these forests over time.

Introduction

We have long recognized that root diseases are common and often very damaging in the forests of the Coeur d'Alene River Basin (Figure 1). Roughly half of the Basin falls within each of the Wallace and Fernan

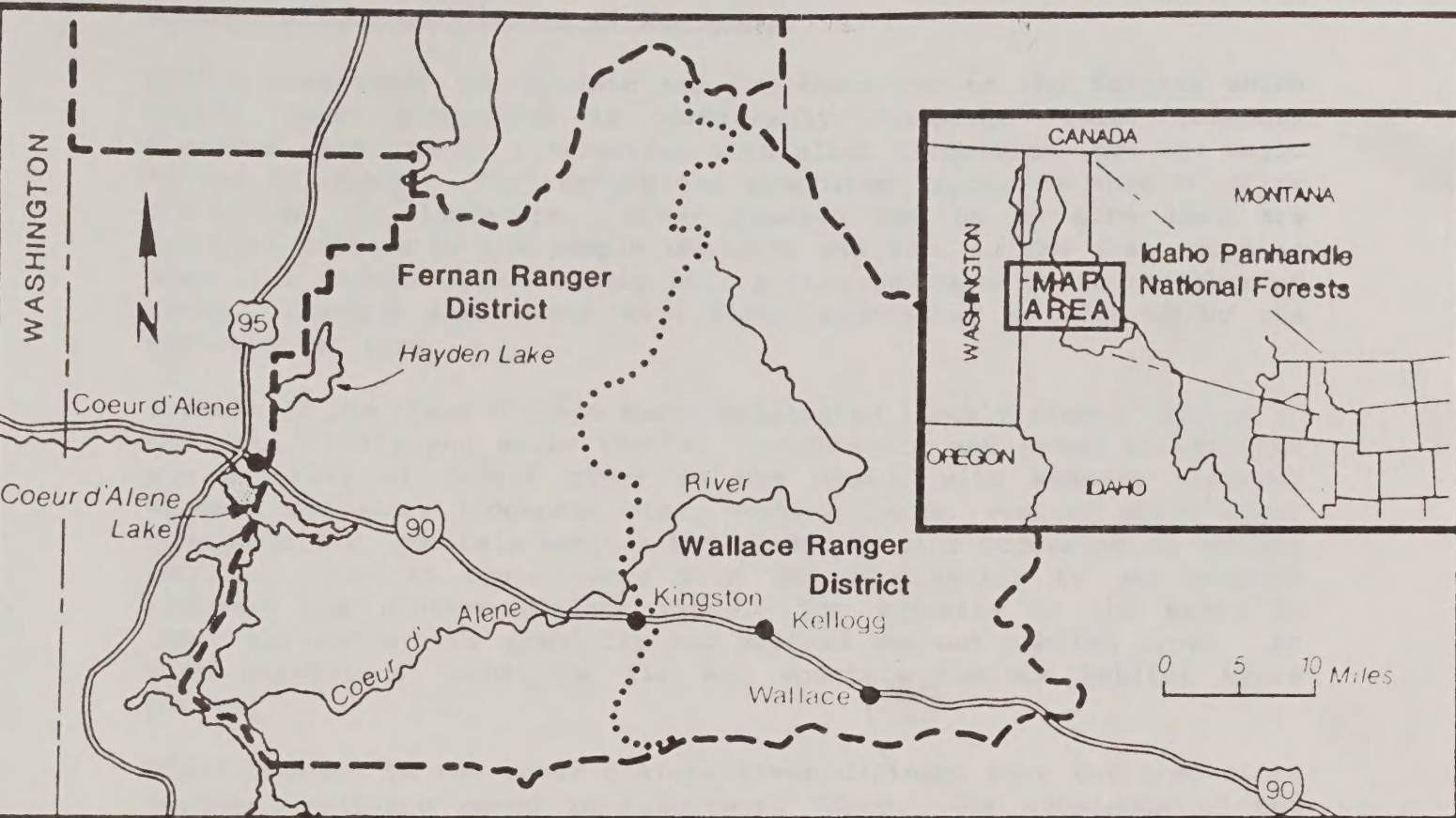


Figure 1. The Coeur d'Alene River Basin.

Ranger Districts, Idaho Panhandle National Forests. The root pathogens most often found on dying trees in the Basin are Armillaria ostoyae, Phellinus weirii, Heterobasidion annosum and Phaeolus schweinitzii. These pathogens are more damaging to Douglas-fir and true firs than to other tree species native to the Basin.

It now seems evident that current species compositions of much of the Basin forests are very different from those prior to the mid-1800's, and that this has been a significant factor in the declining health of these forests.

All of the major tree species found within the mixed conifer forests of the Coeur d'Alene Basin are native; however, the relative amounts of Douglas-fir and grand fir have increased in recent decades above historic levels. As a result of this shift in species composition, the ecology of these forests has been altered and root diseases now play a heightened role in their development.

To plan for the long-term health of the Basin forests, it is necessary to recognize the impact of root diseases in today's forests and to understand the processes that have shaped these forests over time. This report is a preliminary assessment of the current situation of the root disease-infected forests of the Coeur d'Alene River Basin.

Ecology and Recent History of the Basin

Forest ecosystems are dynamic and the character of the forests which typify these ecosystems is continually changing. Fire, insects, diseases, and humans, interacting with plant succession, are the major agents of change. The changes are sometimes rapid, as when wildfire transforms the landscape. Other changes may be so slow they are scarcely noticed by the people who live and work in the area, such as when root disease fungi slowly kill a tree and move on to neighboring trees. Changes also occur when plant succession is altered by the exclusion of fire.

Forests of the Coeur d'Alene Basin originated largely from wildfires in the late 1800's and early 1900's. Douglas-fir and grand fir provide the majority of forest cover in the Basin, with western hemlock, western redcedar, lodgepole pine, western larch, western white pine, subalpine fir, mountain hemlock and ponderosa pine occurring in various amounts. Habitat types range from dry Douglas-fir to wet western redcedar and western hemlock types. The majority of the Basin is characterized by the grand fir and western hemlock habitat types. At high elevations, subalpine fir and mountain hemlock habitat types prevail.

Major changes in the Coeur d'Alene River drainage have occurred since European settlers moved into northern Idaho. Our knowledge of the forest conditions of the late 1800's is incomplete. Nevertheless, it is clear that the Coeur d'Alene Basin was a densely forested region, and contained extensive tracts of conifer forests over 150 years old. Stands of open, old-growth ponderosa pines covered the lower slopes. Mixed stands of subalpine fir and other conifers were present at high elevations. The majority of the area was covered by dense stands dominated by western white pine, usually in combination with western larch, grand fir and other conifers. Douglas-fir was usually present, but "seldom abundant", according to Haig and others (1941). The extensive white pine forests were considered a major commercial resource which brought about a western migration of Eastern sawmill owners who were in short supply of the valuable eastern white pine.

Now, a century later, dense stands of mainly Douglas-fir cover the lower elevations where the open, old-growth stands of ponderosa pine once stood. Dense, mixed stands still cover the white pine zone. In contrast to stand compositions of the past, today's mixed stands are composed primarily of Douglas-fir. Western white pine, while usually present, is seldom abundant.

Fire, insects, and disease have always been a natural part of the Coeur d'Alene River Basin ecosystems, and have been responsible for many forest changes. Fire especially has been a dominant force in the Intermountain area. Frequent, low-intensity ground fires burned through the ponderosa pine forests on a regular basis, killing the more fire-susceptible Douglas-fir, and maintaining the open character of the forest. Less-frequent, hotter fires on the more northerly aspects led to the regeneration of young mixed conifer stands which contained a

significant amount of western white pine and western larch. Root disease fungi thinned the mixed conifer stands and shifted species composition toward western white pine and western larch by selectively killing the more susceptible Douglas-fir and grand fir. As these forests matured they became increasingly susceptible to mortality-causing agents, particularly mountain pine beetle. Increasing volumes of dead wood led to hot stand-replacement fires.

The balance of succession and disturbance that occurred in forests of 150 years ago is very different from changes that have occurred since then, both in degree and kind. The more recent changes are the direct and indirect result of human activities which lead to changes in the ecological balance of forest structure and composition. Fire control and cutting of high-value tree species such as ponderosa pine, western white pine, and western larch have favored the more shade-tolerant Douglas-fir and grand fir. Probably the most significant change was the result of the accidental introduction in the early 1900's of an exotic disease-causing fungus, white pine blister rust (Cronartium ribicola). Intentional burning in the late 1800's (Leiberg 1897) and extensive wildfires in the 1880's and 1910 produced large acreages of young stands. The white pine was virtually eliminated from these stands by blister rust, leaving behind the root disease-prone mixed conifer stands that dominate the Basin today.

The roles of insects and diseases changed when the forests changed. Mountain pine beetle has become less common with the loss of the white pine; however, the Douglas-fir beetle plays a more significant role in response to the species composition of the Basin today. Root diseases, which once were primarily nature's thinning agents in stands composed largely of western white pine, have become major agents of change in today's stands where Douglas-fir and grand fir predominate.

This is not to imply that all human activity has been bad, or that the changes imposed on forests and forest ecosystems have been intentional. It does, however, help to explain the extent and severity of root disease in the area. It also suggests that forest management must deal with the newly-pronounced effects of these native fungi if it is to achieve planned productivity and diversity. Management methods must achieve forest structures and compositions that are in balance with ecosystem processes. Some areas will need rehabilitation. The inherent resistance of western white pine to the blister rust fungus has been increased by the selective breeding efforts of the Intermountain Tree Improvement Cooperative. We now have the opportunity to reestablish the ecological balance that was upset through the inadvertent introduction of blister rust, manipulation of fire, and past timber harvest as we manage forests for the future. Humans can still be agents of change, but can facilitate cycles of change consistent with natural ecological processes.

To better understand the current condition of the forests in the Coeur d'Alene Basin, we have taken a closer look at the severity of root disease and other characteristics of the Basin forests.

Methods

Forest Stands on National Forest System lands within the Coeur d'Alene River Basin were evaluated for presence and severity of root disease. Stands within the grand fir and Douglas-fir forest cover type were stratified by habitat type, age, and stocking. Using a systematic procedure, sample stands were selected and evaluated for root disease using standard resource aerial photography (Table 1). Please see Appendix A for a more detailed discussion of sampling and evaluation methods used in this study.

Table 1. Root disease severity criteria for aerial photography.

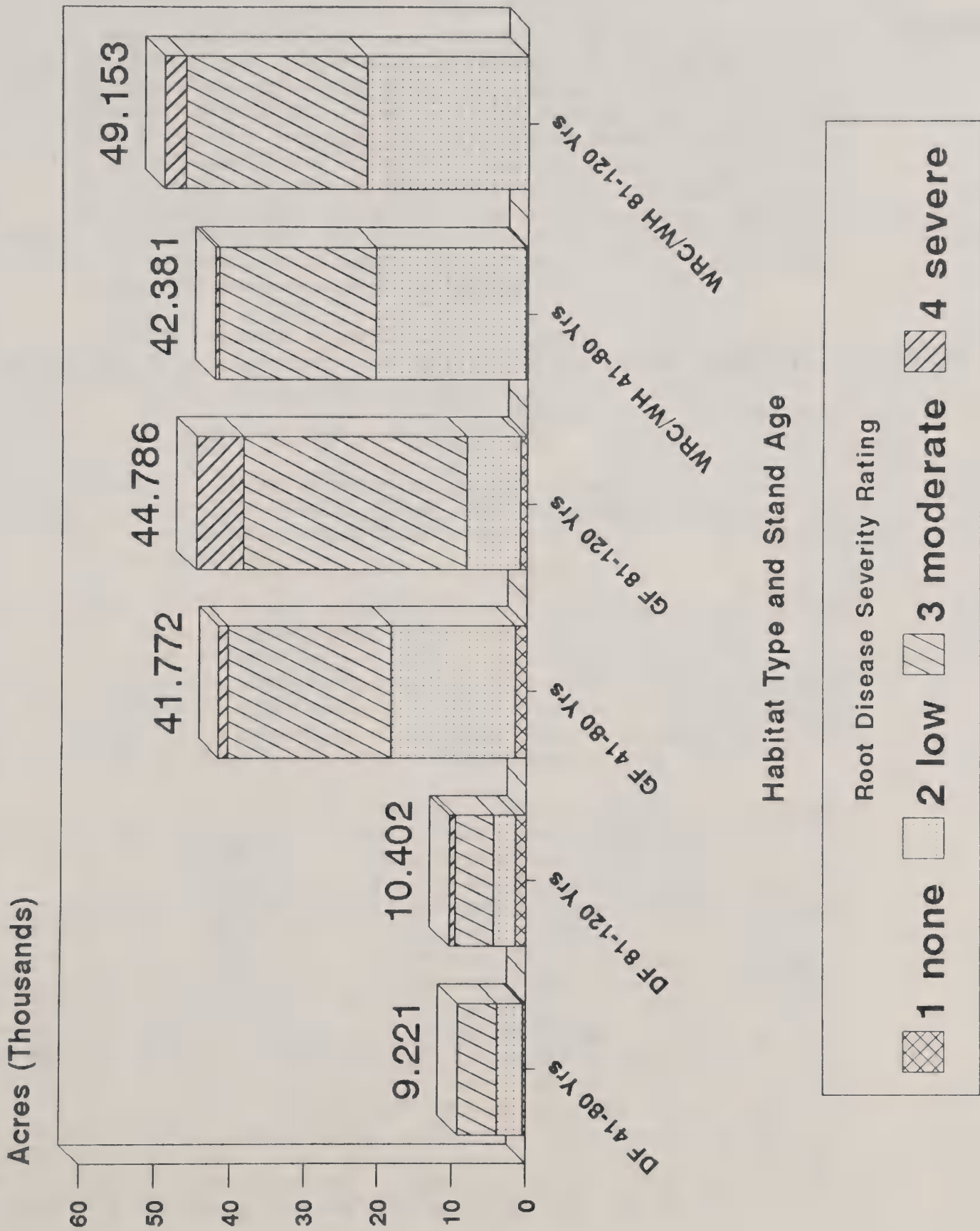
Code	Criteria
1	No evidence of root disease visible in the photograph.
2	Root disease present in small, scattered patches of mortality or few scattered dead trees. Barely distinguishable in photographs or sufficient to serve as distinguishing characteristic for stand delineation. Up to 20 percent canopy reduction.
3	Small and/or large root disease patches obvious, resulting in 21-75 percent overall canopy reduction or 21-75 percent of the stand area in patches which have few remaining overstory trees consistent in age with the non-root disease stand origin.
4	75-100 percent of the stand is in root disease patches which have few remaining overstory trees consistent in age with the non-root disease stand origin. Or scattered mortality has resulted in at least 75 percent reduction in canopy.

From: Hagle, S.K. 1985.

Results

Of the nearly 238,000 acres of stands in the grand fir and Douglas-fir cover types within the Coeur d'Alene River Basin, 98 percent were found to have detectable root disease (35 percent of the Basin). The majority of the stands comprising these root disease-infected acres are in the western redcedar, western hemlock, and grand fir habitat types and are 40-120 years old (Figure 2).

Figure 2: Root Disease Severity by Habitat Type and Stand Age



Root disease severity was strikingly similar between the Wallace and Fernan Districts (Figure 3). The habitat type group with the highest severity was grand fir and the lowest was Douglas-fir. The age class with the highest severity was 121-160 and the lowest was 41-80.

There are approximately 13,800 acres of stands in the grand fir and Douglas-fir cover types (9600 acres on Fernan District and 4200 acres on Wallace District) within the Basin that rated as Severity Class 4 (high severity) (Figure 4). They are distributed among all three habitat type groups. A majority of acres rated severe (8600) are on grand fir or subalpine fir/ Clintonia habitat types. Stands rated severe were generally at least 40 years old and had less than 80 square feet of basal area per acre. The stratum with the greatest proportion of stands rated severe was the grand fir habitat type, 81-120 years old, with 0-80 square feet of basal area per acre. Of the 10,000 acres in this stratum, 50 percent were rated severe.

The most prevalent disease severity was the Severity Class 3 (moderate severity), which was assigned to 57 percent of the stands in the grand fir and Douglas-fir cover types (19 percent of the Basin). In this class, the canopy closure ranges from 20 to 75 percent of what would be expected in the absence of root disease.

Thirty-five percent of the acres in the grand fir and Douglas-fir cover types (12 percent of the Basin) were rated as Severity Class 2. In this class, root disease impact ranges from slight up to 20 percent reduction in canopy closure.

Only 2 percent of the grand fir and Douglas-fir dominated stands in the Basin had no detectable evidence of root disease (Severity Class 1). Strata with the highest proportion of low root disease severity primarily fell in the Douglas-fir habitat type group. Most strata had a minor proportion of acres with no evidence of root disease, but there tended to be a higher proportion of Severity Class 1 acres in the 41-80 age class than in older age classes within a habitat type group.

The western redcedar/western hemlock habitat group, in which Douglas-fir and grand fir are serals, had lower disease severities in the oldest age classes than in the 80-120 age class. This is the expected result of stands progressing to climax species compositions in which the disease-resistant western redcedar and western hemlock become increasingly prominent in the stands and the grand fir and Douglas-fir are lost to root pathogens. The effects of root disease are thus muted. Where Douglas-fir or grand fir are climax, the full impact of root disease is expressed in the oldest age classes. Although stands on western redcedar and western hemlock habitat types probably achieve some recovery because of the relatively resistant climax species, they would typically have a considerable lag time in which the mature Douglas-fir and grand fir are killed and replaced by western redcedar and western hemlock regeneration, which must then mature to produce significant basal area. This sequence may account for the increasing root disease severity from age classes 41-80 to 81-120 to 121-160 followed by a decline in disease severity after age 160 (Figure 5).

Figure 3: Percent of Acres in Douglas-fir and Grand Fir Cover Types by Severity Class

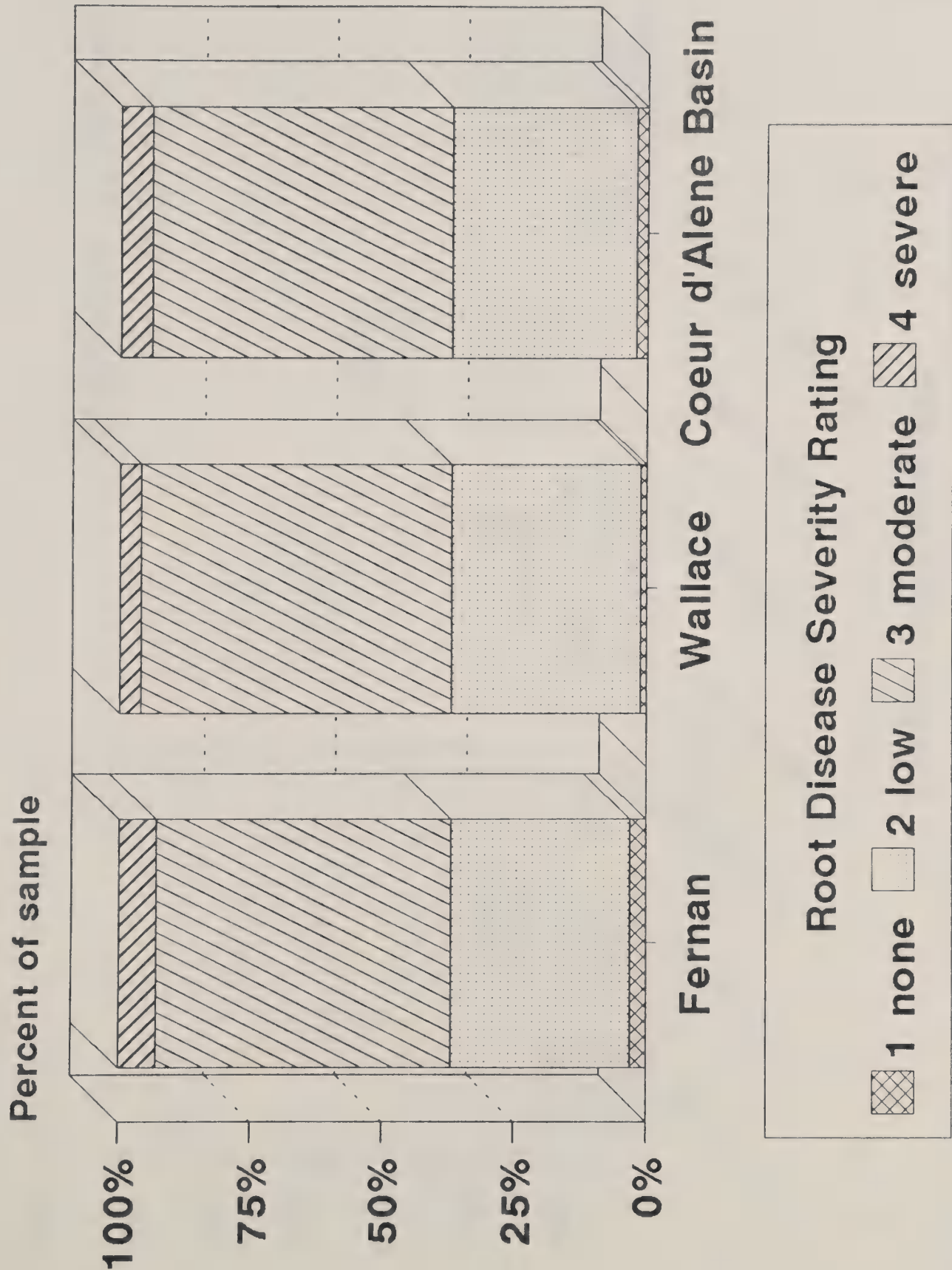


Figure 4: Acres of Severity Class 4 by Habitat Type and Stand Age

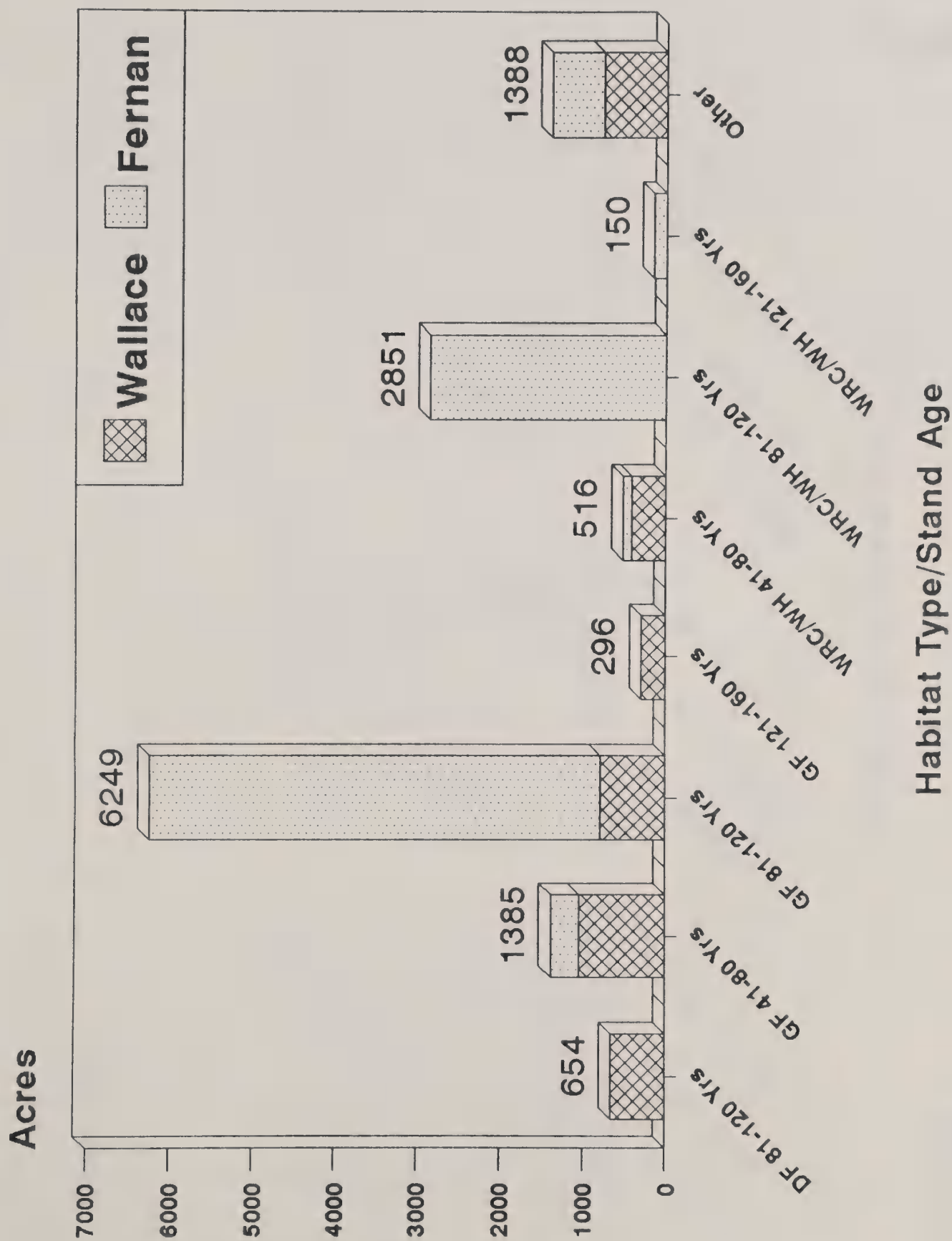
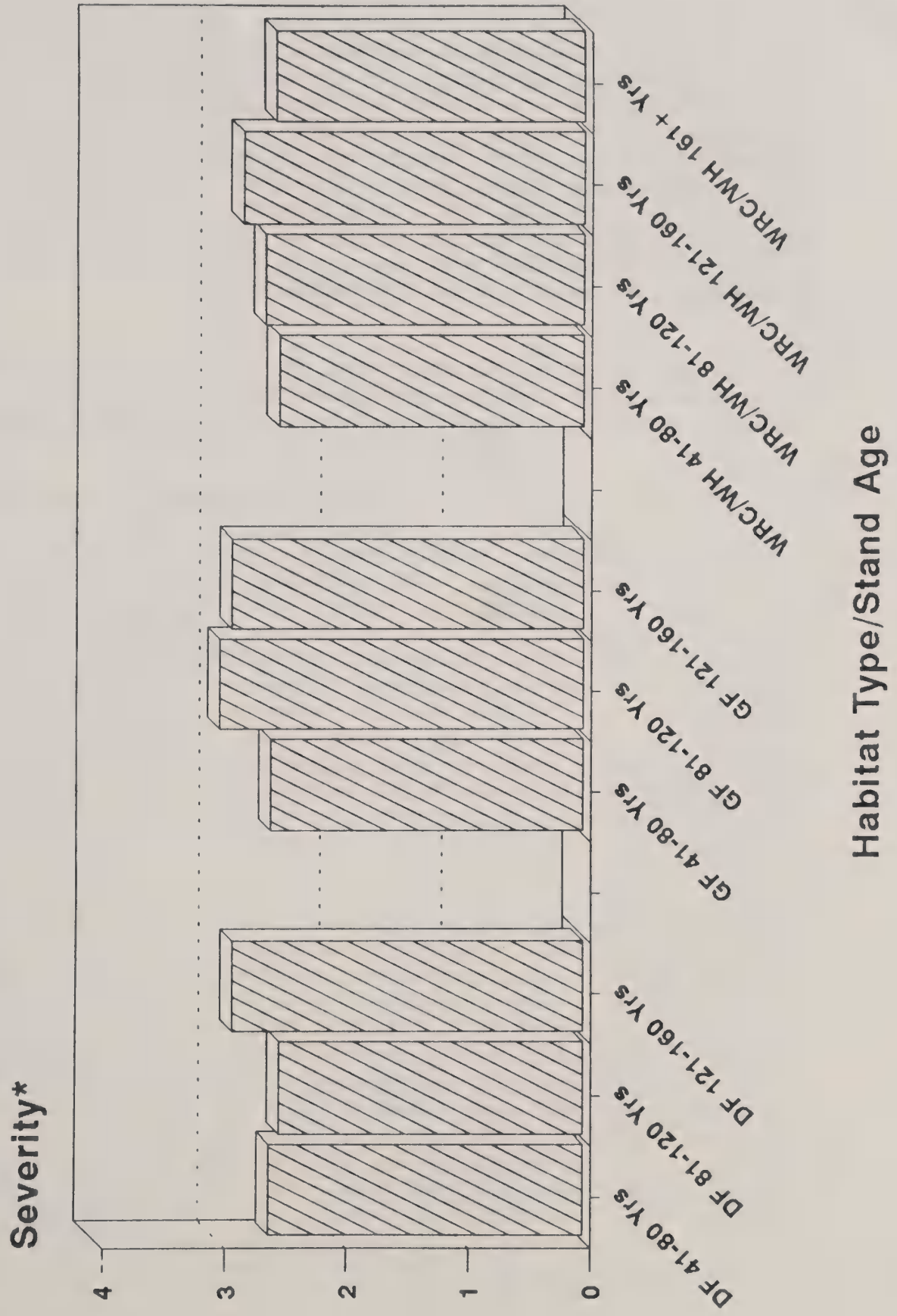


Figure 5: Root Disease Severity by Habitat Type and Stand Age



*weighted average

Discussion

The proportionately greater number of acres of severe root disease in the grand fir habitat type group is consistent with results of the analysis for root disease patch occurrence on the Coeur d'Alene Forest reported by Williams and Marsden (1982). The higher weighted average severity is also consistent with results of other studies of root disease occurrence in northern Idaho and western Montana. Both Byler and others (1990) and McDonald and others (1990) reported finding impacts from Armillaria and Phellinus or Armillaria, respectively, most consistently on grand fir habitat types. This observation is logical from the standpoint of natural succession on these habitat types. The climax (true firs) and major seral species (Douglas-fir) on these habitat types are the most damaged species by the major root pathogens in the area.

The narrow range of severities for all strata may be attributed to the overriding influence of species composition on root disease severity. The project was limited to only those acres where Douglas-fir or grand fir made up a plurality of the species composition.

Root Disease Severity Changes Over Time

The high frequency of root disease impact detected in aerial photographs of the Basin is consistent with previous observations in the area (Williams and Marsden 1982). A. ostoyae, P. weirii, H. annosum and P. schweinitzii are native pathogens in the Basin which have almost certainly evolved in the ecosystem in association with the native conifers. Root system excavations here and in other parts of northern Idaho and western Montana indicate that it is the uncommon Douglas-fir or grand fir that reaches 80 years of age without significant root infections by one or more of these pathogens (Hagle and Goheen 1988). That these root pathogens are well-distributed in the forests of the Basin and naturally abundant in the underground wood which is characteristic of forest sites is indicative of this long history in the Basin.

Patches of active root disease develop as the pathogens overcome infected trees and move to adjacent trees (Kile and others 1991). They infect roots directly through phloem, and invade living cambial tissue. As roots are killed, the fungi decay the root tissue, thereby deriving the energy to attack and overcome additional live tissue. The process of root decay and disease expansion both within a tree and within a stand or ecosystem, is a continual one (Tkacz and Hansen 1982). Root pathogens begin infecting and killing trees from the inception of a stand through maturity and old age. Trees need only be within reach of inoculum to be at risk. The process is one of infection, expansion within a tree, and, if the tree is large enough to provide the fungus with sufficient energy and a suitable host root is within reach, expansion to the next tree. As the trees in a stand grow large, root pathogens gain more energy from a killed host. The presence of less

susceptible tree species in a stand provides proportionally greater resistance to spread of active root disease patches through a stand.

Root disease Severity Class 2 (up to 20 percent canopy reduction) was assigned to 12 percent of the acres in the Basin. Stands which were between 40 and 80 years of age accounted for 40,184 acres rated Severity Class 2 (52 percent of acres in this severity class). Gradual spread of root disease as these stands mature will push many, if not most, of these acres into Severity Class 3 and eventually Severity Class 4. Species compositions which provide greater resistance to root disease will prevent some of these stands from moving into higher severity classes. Stands of western redcedar or western hemlock habitat types may actually show some recovery from root disease because the climax species will gradually increase in prominence in the species composition as the Douglas-fir and grand fir components are reduced. There is some indication of this in the sample from the western redcedar and western hemlock habitat types. The weighted average severity in the 120-160 age class is somewhat lower than that of the 80-120 age class.

Acres With Severely Reduced Productivity

Stands rated Severity Class 4, greater than 75 percent canopy reduction, are of particular interest in this assessment. These are the acres which may require specific action to restore their productivity. Contiguous acres of Severity Class 4 are usually smaller than what would typically be delineated as a stand. Therefore, relatively few stands in this sample were rated as Severity Class 4. It is important to realize, however, that many acres in stands rated as Severity Class 3 will actually have sizable patches, which, if considered individually, would rate as Severity Class 4.

Data indicate that this severity class tends to be most prevalent on the most productive site types where high timber yields are possible. They are typically on grand fir or western redcedar/western hemlock habitat types, are 80-120 years old and yet have less than 80 square feet of basal area. The acres which are Douglas-fir and grand fir habitat types probably have minimum potential for return to full timber production or canopy closure without man's intervention or natural disturbance such as fire, which would allow regeneration of root disease-resistant, seral species (Hagle and Shaw 1991, Kile and others 1991). Those which are on western redcedar or western hemlock habitat types will [probably] slowly return to full stocking and canopy closure as western redcedar and western hemlock increase their stocking on the sites. This will depend upon the abundance of seed sources on site. Even the western redcedar and western hemlock seedlings and saplings are very susceptible to the root pathogens, but those which survive for 30 or 40 years are likely to gain sufficient resistance to overcome most inoculum loads. As the stand slowly shifts more to root disease-resistant, climax species the inoculum loads can be expected to decrease.

Root Disease and the Forest Plan

Of the approximately 238,000 acres in the Coeur d'Alene River Basin that are in the grand fir and Douglas-fir cover types, over 90 percent are in timber management allocations: primarily Management Areas 1, Timber Management; 4, Big-Game Winter Range/Timber Management; and 6, Big-Game Summer Range/Timber Management (Figure 6). This has major resource management implications when considering Forest Plan implementation.

On lands in Management Areas 1, 4, and 6, Forest Plan yield estimates far exceed what is projected for these disease-impacted acres. Table 2 displays the average productivity potential by habitat type group for the Coeur d'Alene Basin study area. These average site productivity potentials form the basis for Forest Plan yield projections.

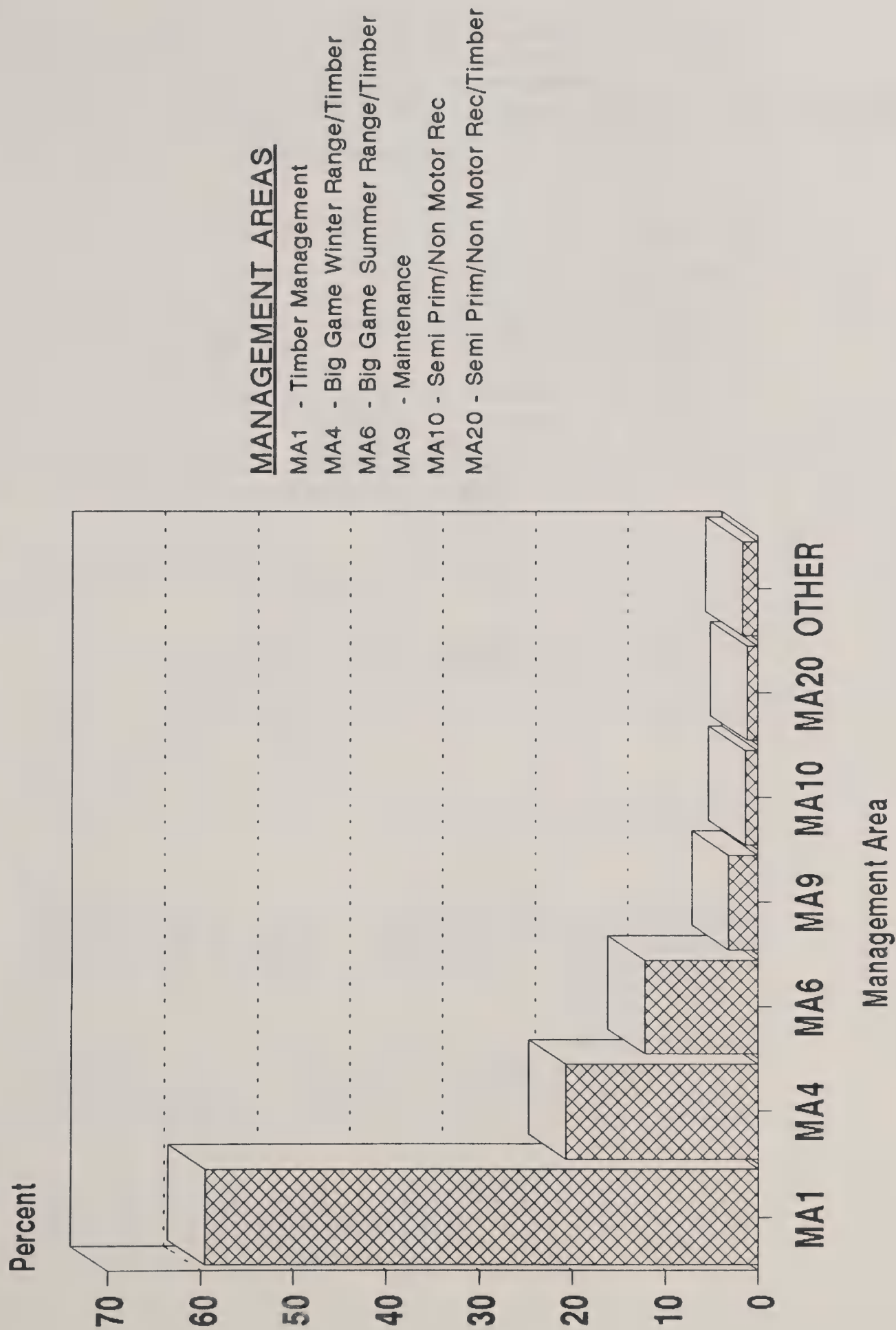
Table 2. Average site productivity potential by habitat type group.

Habitat Type Group	Inclusive Habitat Types	Common Names	Average Site Productivity Potential (cu.ft./ac/year)
1	530 570	Western redcedar/beadlily Western hemlock/beadlily	80-130
2	520	Grand fir/beadlily	70-120
3	620	Subalpine fir/beadlily	60-100
4	260 310 320	Douglas-fir/ninebark Douglas-fir/snowberry Douglas-fir/pinegrass	40-100
5	690	Subalpine fir/beargrass	40-70

Yield projections for sites impacted by root disease within the Horizon Forest Resource Area show, on the average, a negative growth rate (-4 cubic feet per acre per year): timber volume lost to mortality would exceed timber growth. These projections may be representative of stands with similar root disease impact elsewhere in the Coeur d'Alene Basin. The Horizon analysis concludes that, given no management intervention, these acres clearly would not meet Forest Plan land allocation objectives for timber production in Management Areas 1 and 4 in this decade, or over the long term.

In addition, forest canopy projections for stands within the Horizon Forest Resource Area show that in stands with high root disease severities in Habitat Type Group 1, without management intervention,

**Figure 6: Percent of Acres in Douglas-fir and Grand Fir Cover Types
by Management Area**



canopy closure is roughly 65 to 75 percent of theoretical full canopy closure. This has a direct effect on the ability of these stands to meet the canopy cover requirements of lands in Management Areas 4 and 6. This reduction in canopy closure also has a direct effect on the hydrologic recovery of forested lands across all management area allocations within the Coeur d'Alene study area.

Conclusions

Root diseases are a major influence in the Coeur d'Alene Basin forests. The ecosystem has been altered by loss of a majority of the western white pine component, alteration of natural fire regimes, and selective tree harvest. Root disease fungi are probably more prevalent and damaging in this ecosystem currently than in previous centuries, and considerable time may be required for a new balance to be achieved. The purpose of this project was to assess the current status of root disease in the Basin forest ecosystem and develop a basis for projecting the rates and paths of future changes in these forests. Following are several conclusions resulting from this assessment.

1. Fernan and Wallace Districts are similar in their root disease status, both in constancy and severity.
2. Root disease occurs with a high constancy in the 80-120 age class, which is the most abundant age class in the Basin.
3. A high proportion of acres was rated a low root disease severity, but can be expected to progress to moderate and severe levels with time.
4. Most of the 40-80 year-old stands had low to moderate root disease severity, but can be expected to increase in severity with age.
5. Approximately 13,800 acres in the Basin are in stands with extremely low basal area as a direct result of root disease impact. These stands may remain out of significant tree production for extended periods without natural fire or management intervention.
6. The majority of Douglas-fir and grand fir cover types occur in management areas designated for timber production. The differences between productivity projections used in the Forest Plan and projections which account for losses to root disease are striking.
7. Sufficient evidence of root disease within the forests of the Coeur d'Alene River Basin supports further analysis of the impacts of the root diseases on the timber, wildlife, and water resources of the Basin.

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Appendix A. Methods

Forest stands on National Forest System lands within the Coeur d'Alene River Basin were selected for systematic sampling using the Regional database. Of 732,000 acres in the basin, 365,000 are on the Fernan Ranger District and 367,000 are on the Wallace Ranger District. A high proportion of both the Wallace and Fernan Ranger Districts have been inventoried on-the-ground, so a relatively complete database is available from which to characterize the forests of the Basin. Stand data were available for 86 percent of the stands.

Stratification

Forest cover type

Stands were initially stratified on the basis of forest cover type.

Stands classified as Douglas-fir or grand fir cover types contained a plurality of basal area of Douglas-fir or grand fir, respectively. Thirty-three percent of the Basin forests (238,306 acres) were found to be in the Douglas-fir and grand fir cover types.

Other cover types were largely lodgepole pine, ponderosa pine, western redcedar, western hemlock or western larch. While root disease will impact these types, particularly the Douglas-fir and true fir components of these types, they are generally less damaged as a whole because of the lower proportion of Douglas-fir and true firs. As a result, these stands were not analysed further.

Stands within the Douglas-fir and grand fir cover types were separated from the main population and further stratified by habitat type, stand age, and basal area.

Habitat type

Stands within the Douglas-fir and grand fir cover types were stratified according to habitat type group (Table A1). Habitat types were grouped according to their similarity in productivity, species composition, and probable root disease impact.

Stand age

The stands were then stratified by the age class of the manageable component. That is, if the stand had a scattered mature overstory but an understory of seedlings and saplings, it would be classified as age 0 - 40 because the understory would be considered the manageable component.

Five age classes were used: 0 - 40, 41 - 80, 81 - 120, 121 - 160, and 161+ years.

Table A1. Acres in Douglas-fir and grand fir cover types by habitat type group.

Habitat type group	Acres by Area		
	Wallace	Fernan	Basin
Douglas-fir types	11,464	10,653	22,117
Grand fir types and subalpine fir/Clintonia	43,885	56,020	99,905
Western redcedar types and western hemlock types	47,867	68,417	116,284
Total	103,216	135,090	238,306

Basal area

Finally, the stands were further stratified by the total square feet of basal area per acre. Root disease commonly reduces stand basal area by killing mature or nearly mature trees. Stand age and site productivity also influence stand basal area. Within age and habitat type classes, basal area may provide a reasonable grouping of root disease-impacted stands.

Three stocking strata were used: 0 - 80, 81 - 160, and 161+ square feet of basal area per acre.

The stratum abbreviations and number of acres in each stratum are shown in Table A2. Six strata contained the majority of acres on both the Fernan and Wallace Ranger Districts: western redcedar/western hemlock, 81-120 years old; grand fir, 81-120 years old; western redcedar/western hemlock, 41-80 years old; grand fir, 41-80 years old; Douglas-fir, 81-120 years old; and Douglas-fir, 41-80 years old.

Photo Sampling

Patterns of mortality, stand structure, and stocking which are indicative of root disease are generally discernable in mature stands from high quality true color aerial photographs at scales of 1:25,000 or less (Williams and Leaphart 1978).

All strata containing stands greater than 40 years old were sampled. A one in five (approximately 20 percent) sample of stands was selected from strata in the greater than 40 years age class, judged most significant on each District. Strata with small numbers of stands were

Table A2. Strata

Abbrev.	Habitat type	Age class	Stocking Class BA (sq.ft.)	Acres in stratum		
				Wallace	Fernan	Basin
D1a	Douglas-fir	0-40	0-80	686	74	760
D1b		"	81-160	133	0	133
D1c		"	161+	81	0	81
D2a		41-80	0-80	2,796	2,132	4,928
D2b		"	81-160	2,278	1,202	3,480
D2c		"	161+	397	416	813
D3a		81-120	0-80	2,479	2,109	4,588
D3b		"	81-160	1,369	3,014	4,383
D3c		"	161+	436	995	1,431
D4a		121-160	0-80	91	387	478
D4b		"	81-160	246	270	516
D4c		"	161+	0	54	54
D5a		161+	0-80	46	0	46
D5b		"	81-160	0	0	0
D5c		"	161+	426	0	426
Subtotal				11,464	10,653	22,117
G1a	grand fir	0-40	0-80	2,623	1,792	4,415
G1b		"	81-160	1,433	0	1,433
G1c		"	161+	1,586	0	1,586
G2a		41-80	0-80	7,925	6,147	14,072
G2b		"	81-160	8,349	9,532	17,881
G2c		"	161+	5,087	4,731	9,818
G3a		81-120	0-80	3,637	6,378	10,015
G3b		"	81-160	6,279	16,158	22,437
G3c		"	161+	4,184	8,149	12,333
G4a		121-160	0-80	1,235	710	1,945
G4b		"	81-160	1,030	1,397	2,427
G4c		"	161+	290	1,026	1,316
G5a		161+	0-80	227	0	227
G5b		"	81-160	0	0	0
G5c		"	161+	0	0	0
Subtotal				43,885	56,020	99,905
H1a	western redcedar/ western hemlock	0-40	0-80	3,168	2,843	6,011
H1b		"	81-160	1,554	0	1,554
H1c		"	161+	2,518	0	2,518
H2a		41-80	0-80	3,554	3,335	6,889
H2b		"	81-160	8,766	10,838	19,604
H2c		"	161+	6,856	9,033	15,889
H3a		81-120	0-80	4,261	4,204	8,465
H3b		"	81-160	4,314	19,176	23,490
H3c		"	161+	4,943	12,255	17,198
H4a		121-160	0-80	2,099	494	2,593
H4b		"	81-160	2,403	2,991	5,394
H4c		"	161+	1,718	2,331	4,049
H5a		161+	0-80	1,242	260	1,502
H5b		"	81-160	79	265	344
H5c		"	161+	392	392	784
Subtotal				47,867	68,417	116,284
TOTAL				103,216	135,090	238,306

sampled more intensively to ensure an adequate number of samples. The sampling intensity for strata ranged from 16 to 100 percent but averaged 21 percent.

Sample stands were delineated on true color aerial photographs (1:12000). From the photographs the stands were assigned root disease severity ratings (Hagle 1985) ranging from 1 to 4. The photographs were viewed using portable stereoscopes with 10X microscopic lenses. Table A3 presents the criteria for assigning the severity codes.

Table A3. Root disease severity criteria for aerial photography.

Code	Criteria
1	No evidence of root disease visible in the photograph.
2	Root disease present in small, scattered patches of mortality or few scattered dead trees. Barely distinguishable in photographs or sufficient to serve as distinguishing characteristic for stand delineation. Up to 20 percent canopy reduction.
3	Small and/or large root disease patches obvious, resulting in 21-75 percent overall canopy reduction or 21-75 percent of the stand area in patches which have few remaining overstory trees consistent in age with the non-root disease stand origin.
4	75-100 percent of the stand is in root disease patches which have few remaining overstory trees consistent in age with the non-root disease stand origin. Or scattered mortality has resulted in at least 75 percent reduction in canopy.

From: Hagle, S.K. 1985.

The sample was selected using a list of stands in numerical order within each stratum. For the first stratum on the Wallace Ranger District, the first stand on the list and every fifth stand thereafter was selected. For each successive stratum we advanced one additional stand for the first selection to avoid over-selection of the lowest-numbered compartment on the District. On the Fernan Ranger District, the first stand on each list was rated, and at least every fifth stand thereafter.

For the Fernan District, we used the sample from the Horizon EIS (USDA 1991) in the Wolf Lodge drainage to represent the 80-120 years age class. We judged the Horizon EIS sample to be representative of this

age class for the District; the extensive sample provided a sampling intensity that more than met our needs for this assessment. Habitat type groups and photo rating procedures used in the Horizon analysis were identical to those used in this assessment.

Severity Rating of Young Stands

Root disease symptoms and patterns are not easily discernable in young stands because small trees are difficult to distinguish on photographs, and the patterns of disease are rarely well developed in young stands. The age at which root disease is detectable and severity rating is possible from aerial photographs varies by density, site productivity and species composition. For this assessment, we assumed that stands less than 40 years old would not provide useful signatures on aerial photographs for severity rating.

Of the age classes above 40 years, 48 percent of the stands in the Douglas-fir and grand fir cover types in the Basin are between the ages of 81 and 120 years. Most of the remaining stands (44 percent) are in age class 41-80. Therefore, we reasoned that most of the harvested sites which are now less than 40 years of age probably had supported stands over 80 years old at the time of harvest.

Root disease severity will be changed significantly from one generation to the next on a site if the species composition is significantly altered. If the young stand derived from an 81-120 year age class stand is now stocked with pines or larch, the stand is likely to have a much-reduced level of root disease severity. Therefore, we excluded all stands in the 0-40 years age class that had been designated by a silviculturist as Certified or Progressing. Either of these designations implies that the stand has been examined by the silviculturist and was found to be adequately and suitably stocked. We also excluded stands in this age class that were known to be poorly stocked because of brush competition following tree harvest or wildfire.

Based on these two assumptions: that age 0-40 stands were the result of harvesting stands in the 81-120 age class; and that stands which are neither Certified or Progressing nor known brushfields have similar tree species compositions to the previous generation, the remaining stands in the less-than-40-years age class were partitioned into root disease severity classes on the basis of frequencies of severity levels assigned to the 81-120 age class by habitat type. Partitioning in this age class is for the purposes of gauging our probable position in the future on these acres with respect to root disease, rather than an attempt to accurately reflect current mortality rates or stocking levels in these stands.

There were 18,491 acres identified within the 0-40 age class. Four percent of the stands falling within this group were reapportioned to other strata after viewing the aerial photography. They most commonly appeared to be stands in the 80-120 age class that had been given no age or an erroneous age in the database.

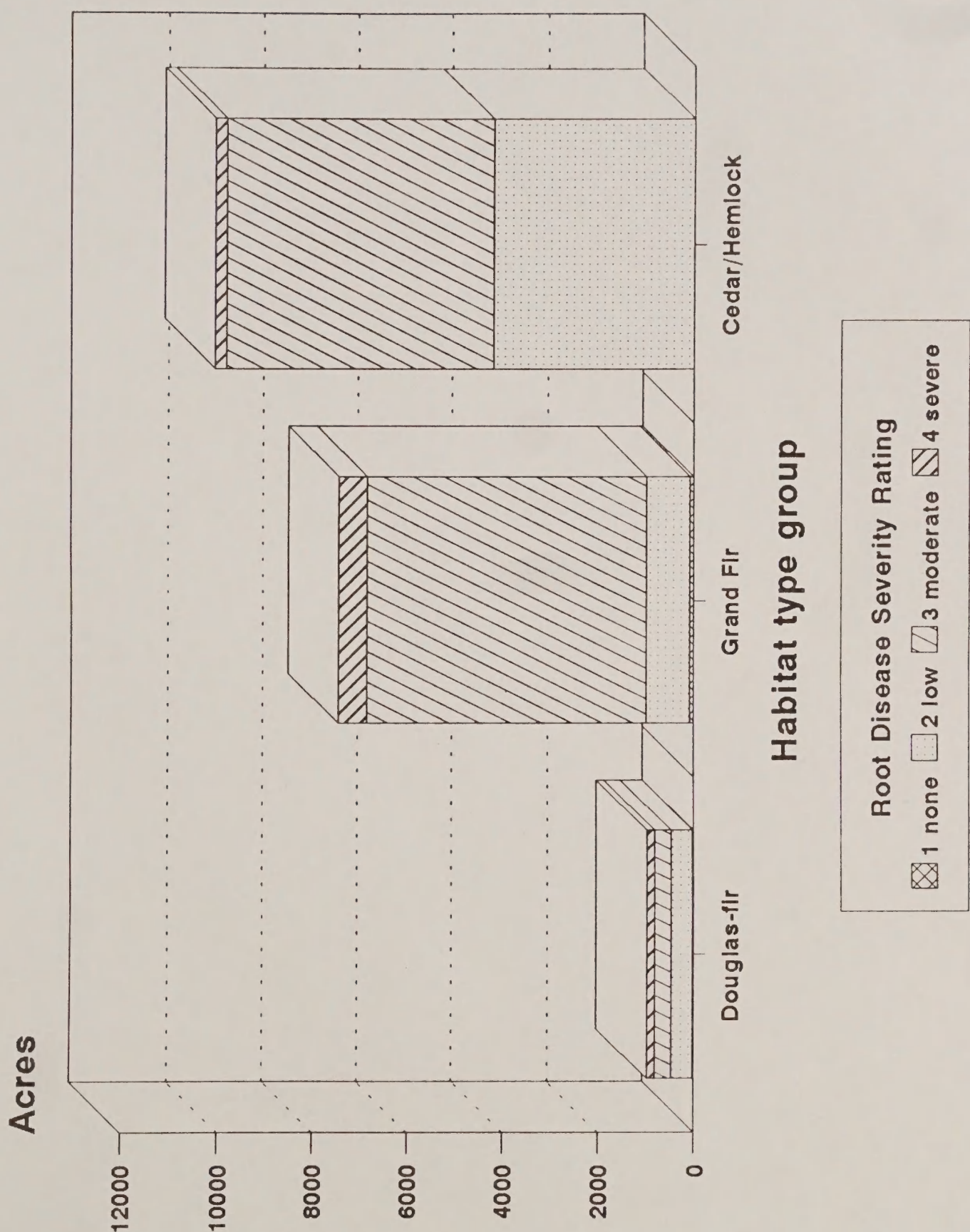
The distribution of acres in the 0-40 age class by habitat types (Table A4) is similar to that of the 81-120 age class.

Table A4. Comparing 0-40 and 81-120 age classes by habitat type frequencies (percent of acres in each habitat type class).

Habitat type group	Age Classes					
	Fernan		Wallace		Basin	
	0-40	81-120	0-40	81-120	0-40	81-120
Douglas-fir	2	8	7	13	5	10
Grand fir, subalpine fir/ clintonia	38	42	41	44	40	43
Western redcedar, western hemlock	60	49	53	42	55	47

Within the Coeur d'Alene River Basin, The cedar/hemlock habitat type group contained 55 and 47 percent of the 0-40 and 81-120 age class acres, respectively. The grand fir group contained 40 and 43 percent and Douglas-fir contained 5 and 10 percent. Root disease severity assigned according to the distribution in the 81-120 age class placed over 6000 acres of the 0-40 age class in the moderate to severe root disease severity classes (Figure A1).

Figure A1: Root Disease Severity in the 0 - 40 Age Class



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